Space Weather Technical Forecast

Issued on Friday, 22 March 2024 at 13:09 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: M-flares likely (R1-R2 Radio blackouts), slight chance of X-flares (R3 blackouts). Chance G1/Minor Storm from fast wind onset of CH12/- on day 3 (24 Mar).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Low, with the largest flare a C5.8 peaking at 21/1819 UTC from AR3614 in the northeast. Frequent C-class flares have also been observed from AR3615. There are currently ten sunspot regions on the visible disc however AR3615 is the largest and most notable, with ongoing development. This consists of a number of small but dark umbrae which are gradually merging into larger spots, but also with a moderately strong delta-configuration within its trailer. Despite the recent lack of flaring, the spot has increasing magnetic flux associated with it, and continues to grow in size. The other spots on the disc remain smaller and simpler, with little growth, including AR3614 which is gradually declining.

A broad filament eruption was observed off the northeast disc around 21/1800 UTC. This has been assessed as missing Earth, to the north and east. No other potentially Earth-directed CMEs have occurred.

Solar Wind / Geomagnetic Activity: Ongoing effects of the 17 Mar CME were observed at first with a clear magnetic cloud passage, before a return to ambient slow wind conditions. Solar wind speed observed by ACE at L1 was at background 320-380 km/s. Density was around average. Interplanetary Magnetic Field (IMF), Bt, was initially Moderate, ranging 8-13nT, easing slightly be 6-10nT by the end of the period. The north-south component, Bz, was moderately negative (southward), at -12nT at first. After a brief moderate positive (northward) switch, peaking +12nT, this showed a gradual rotation to mainly positive values by the end of the period, reaching a peak of around 8nT. Geomagnetic activity was Active (Kp4) at first, with one G1 Minor Storm interval 21/1500-1800 UTC. Activity then eased to be Unsettled (Kp3) from 22/00000 UTC.

Energetic Particles / Solar Radiation: GOES18 high energy (greater than 10MeV) proton flux is at background. High energy electron flux (greater than 2MeV) observed at GOES16 was at background. The observed 24-hour fluence was below the Active threshold, with a value at 22/0000 UTC of 9.86e5 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Low to Moderate activity expected with a likelihood of isolated M-flares. There is a slight chance of isolated X-flares, from AR3615.

Solar Wind / Geomagnetic Activity: There are no Earth-directed CMEs. The next notable enhancement will be from the arrival of the fast winds of CH12/-, most likely on day 3 (24 Mar), with slightly elevated to elevated solar winds forecast (450-500km/s). Mainly Quiet geomagnetic activity is expected until this arrival. Activity then becoming Unsettled to Active with a chance of isolated G1 Minor Storm intervals, most likely day 3 (24 Mar). Activity then easing to be mostly Quiet to Unsettled with a slight chance of Active intervals by the end of the period.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux at

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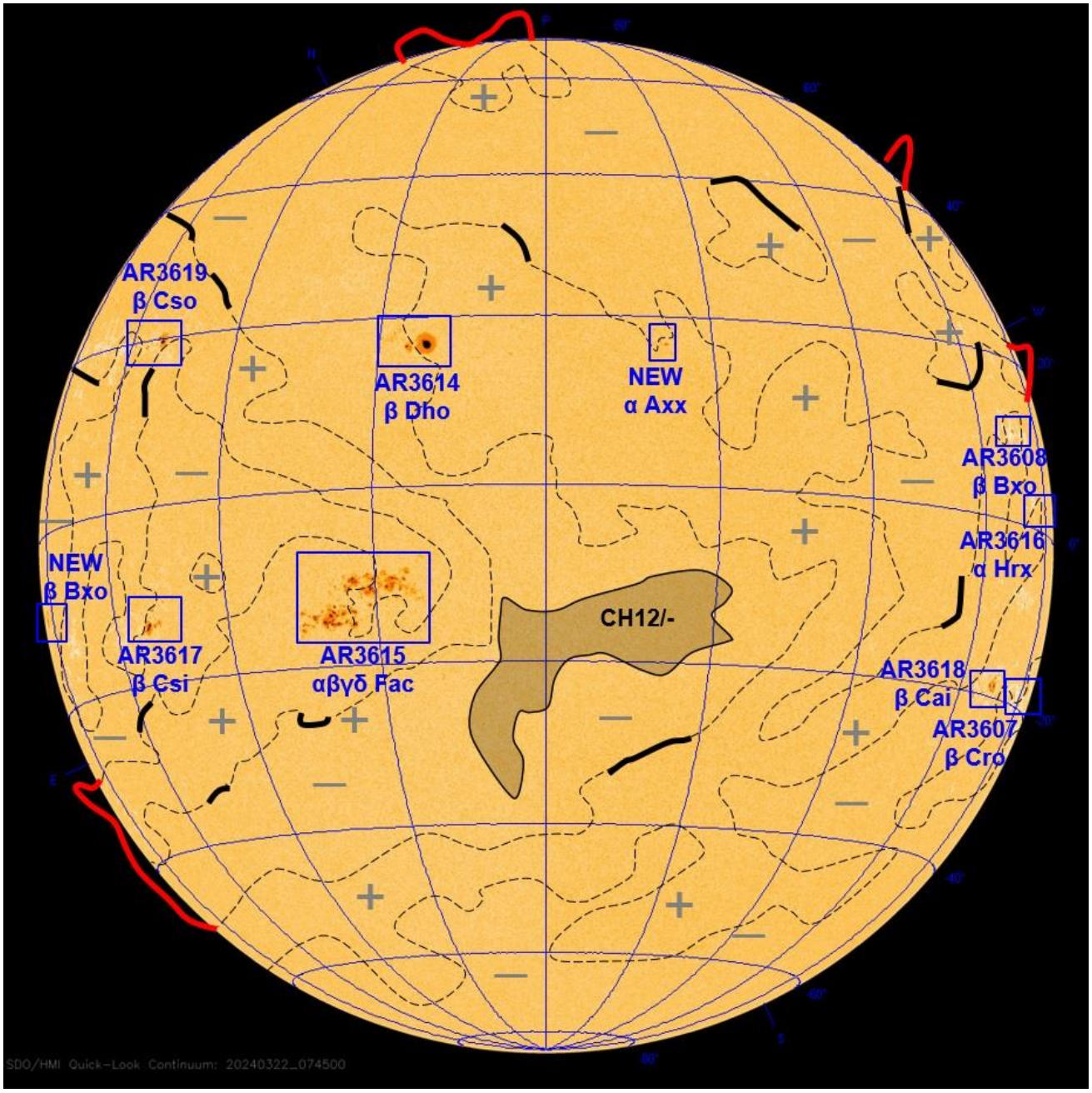
GOES18 is expected to persist at background. There is a slight chance of enhancement from any notable flaring from AR3615. High energy electron flux (greater than 2MeV) is expected to persist at mainly background levels until later day 3 or day 4 (24-25 Mar). The associated 24 hour fluence is expected to persist below the Active threshold, but with a rising trend possible on day 4 (25 Mar).

Figure 1. Solar Analysis Valid 22/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There are no Earth-directed CMEs, with the filament eruption.

Mainly Quiet geomagnetic activity at first, before the onset of the fast wind from CH12/-. This coronal hole is expected reach its apparent geoeffective longitude on day 3 (24 Mar) with observed solar winds expected to rise in response, to be slight elevated (around 450 km/s), perhaps briefly becoming elevated (500 km/s). This is a persistent feature, with solar winds of around 450 km/s observed on the previous rotation, along with an isolated G1 Minor Storm interval. Given the proximity of the spring equinox (Russel-McPherron effect), coupled with the persistence of the feature, similar conditions are also likely on this occasion. Slightly elevated solar winds then persist through day 4 (25 Mar). MOSWOC Enlil currently has this fast wind passing south of Earth, leading to some uncertainty, however given the location a stronger connection is favoured in the forecast.

Geomagnetic activity is forecast to increase on day 3 (24 Mar) to be Unsettled to Active, with the chance of an isolated G1 Minor Storm interval. This easing day 4 (25 Mar) to be Quiet to Unsettled with a chance of Active intervals.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	Yes	1	5	50	10
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Figure 2a: Solar wind persistence Model

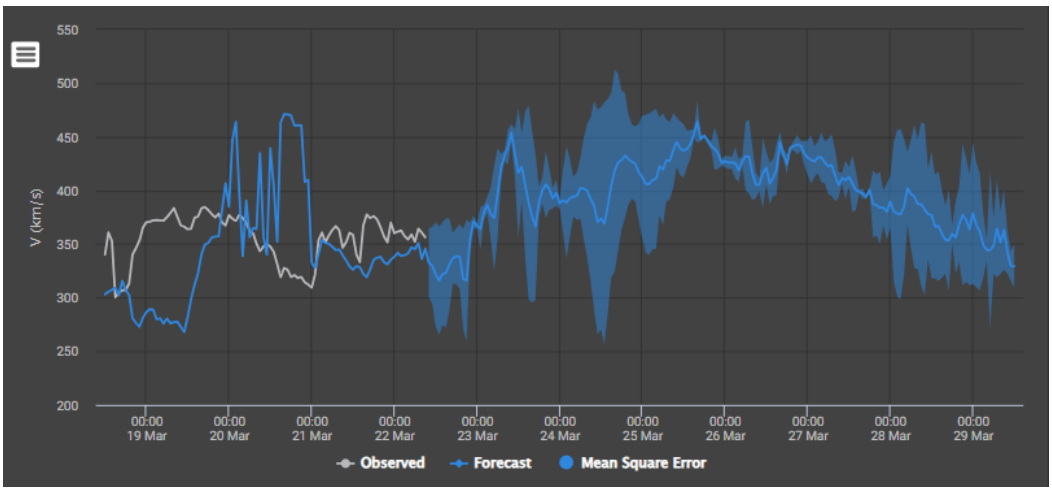

Figure 2b: SDO aia 211 of current and previous rotation, showing similar coronal hole location, although structure is a little difference. While further west on last rotation, bulk darkest part of the CH was similar, perhaps a touch further south and east

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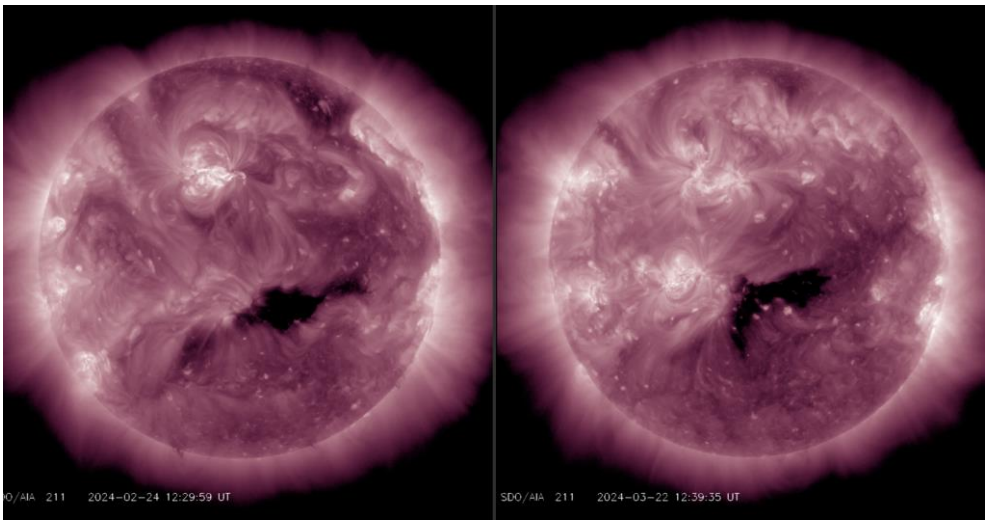


Figure 2: Potsdam music plots showing Kp5 on last rotation (27 Feb), from when the main bulk of the coronal hole arrived, which was further west

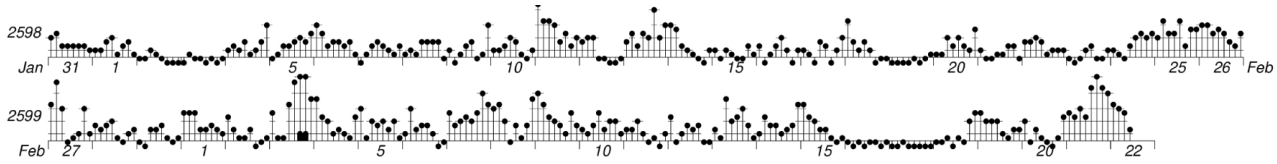
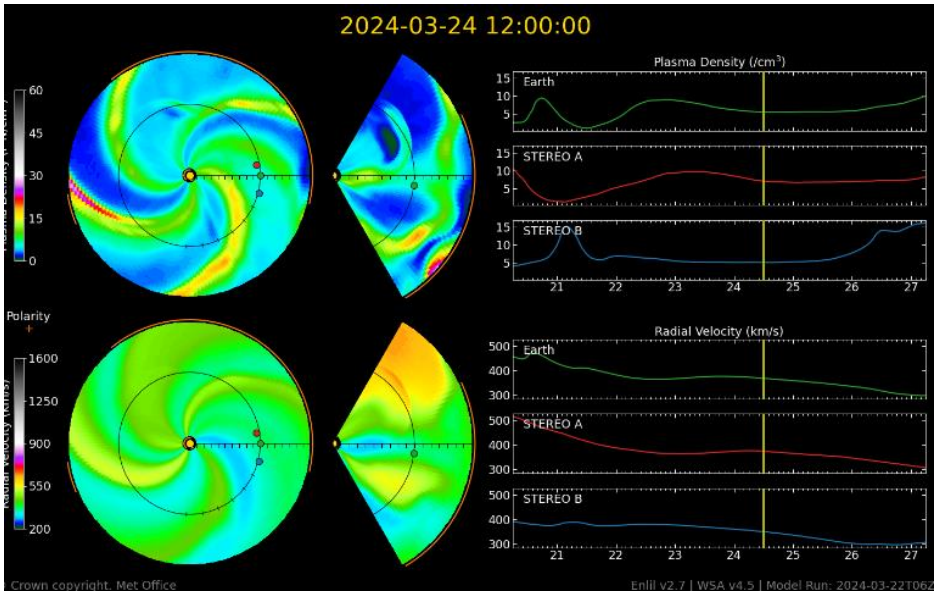


Figure 2: Enlil showing CH to the south, adding uncertainty. CME can be seen passing north of Earth on the same day.



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Radio Blackouts - X-Ray Flares:

Low to Moderate activity is expected with a likelihood of isolated M-class flares and a slight chance of X-class flares.

AR3615 in the southeast is the most notable of the ten regions currently on the visible disc, and the most likely source of any flares. This has continued to develop during the last 24 hours, with a number of small but dark umbrae forming, along with a moderately strong delta-spot in the main trailer. The penumbra of each spot is also gradually merging leading to an overall growth in areal extent. The other regions on the disc tend are simpler, with little growth occurring, but do contribute to the overall chance for further M-class flares.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	60	60	55	50
Very Active	R3 to R5 X Class	No	15	15	10	10

Figure 3: GOES 16/18 X-ray Flux

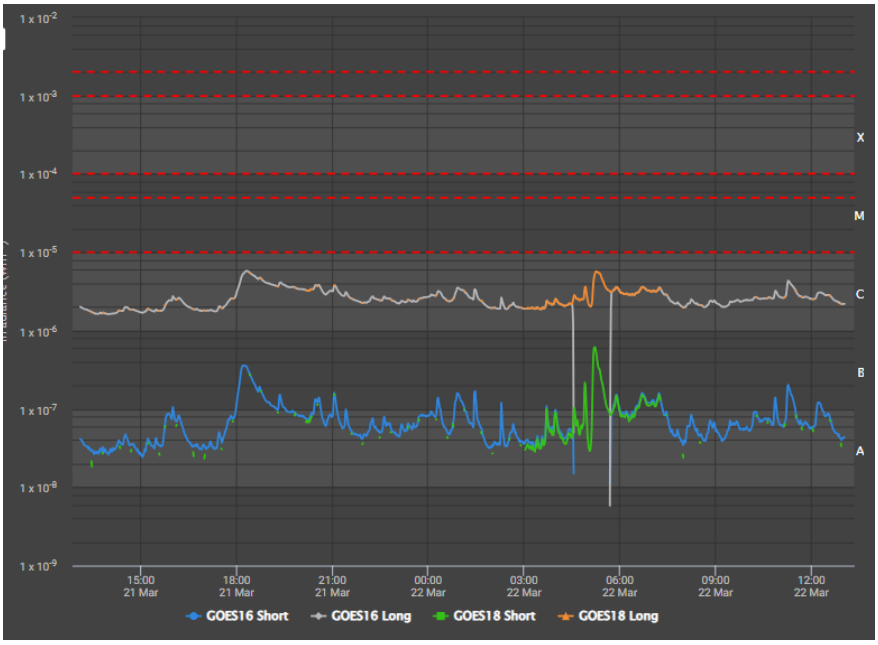

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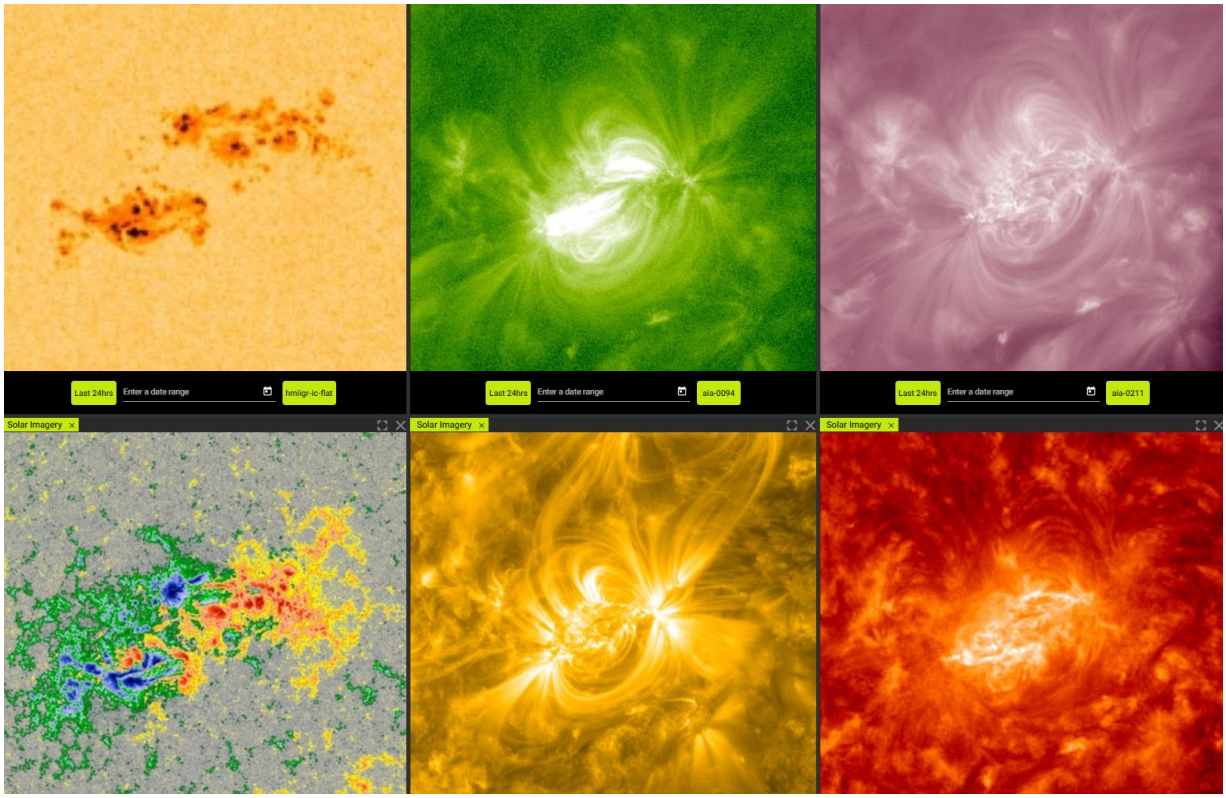
Figure 4: SDO imagery of AR3615



Solar Radiation Storms - (High Energy Protons):

High energy proton flux, as observed by GOES-18 is currently at background, and likely to persist at this level. However, as AR3615 moves into the centre disc and then into the western hemisphere there is a slightly increasing chance of any notable flares resulting in a proton enhancement being observed. This gives a very slight chance of reaching the S1 threshold.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	10	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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High Energy Electrons Event (≥ 2MeV):

GOES-16 high energy electron flux is expected to remain at background days 1-3 (22-24 Mar) before the next potential enhancement occurs from the fast wind of coronal hole 12. Once any associated geomagnetic activity eases, the electron flux at GEO is likely to rise to Moderate, with a slight chance of reaching High by the end of day 4 (25 Mar). This is low confidence however, as the source coronal hole (CH12/-) is a persistent feature and no electron flux enhancement was observed on the previous rotation.

The associated 24 fluence is expected to remain below the Active threshold with MOSWOC REFM providing good guidance until the onset of this fast wind. Fluence is likely to rise a little day 4 (25 Mar) with a slight chance of reaching Active fluence by the end of the period.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	1	10
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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